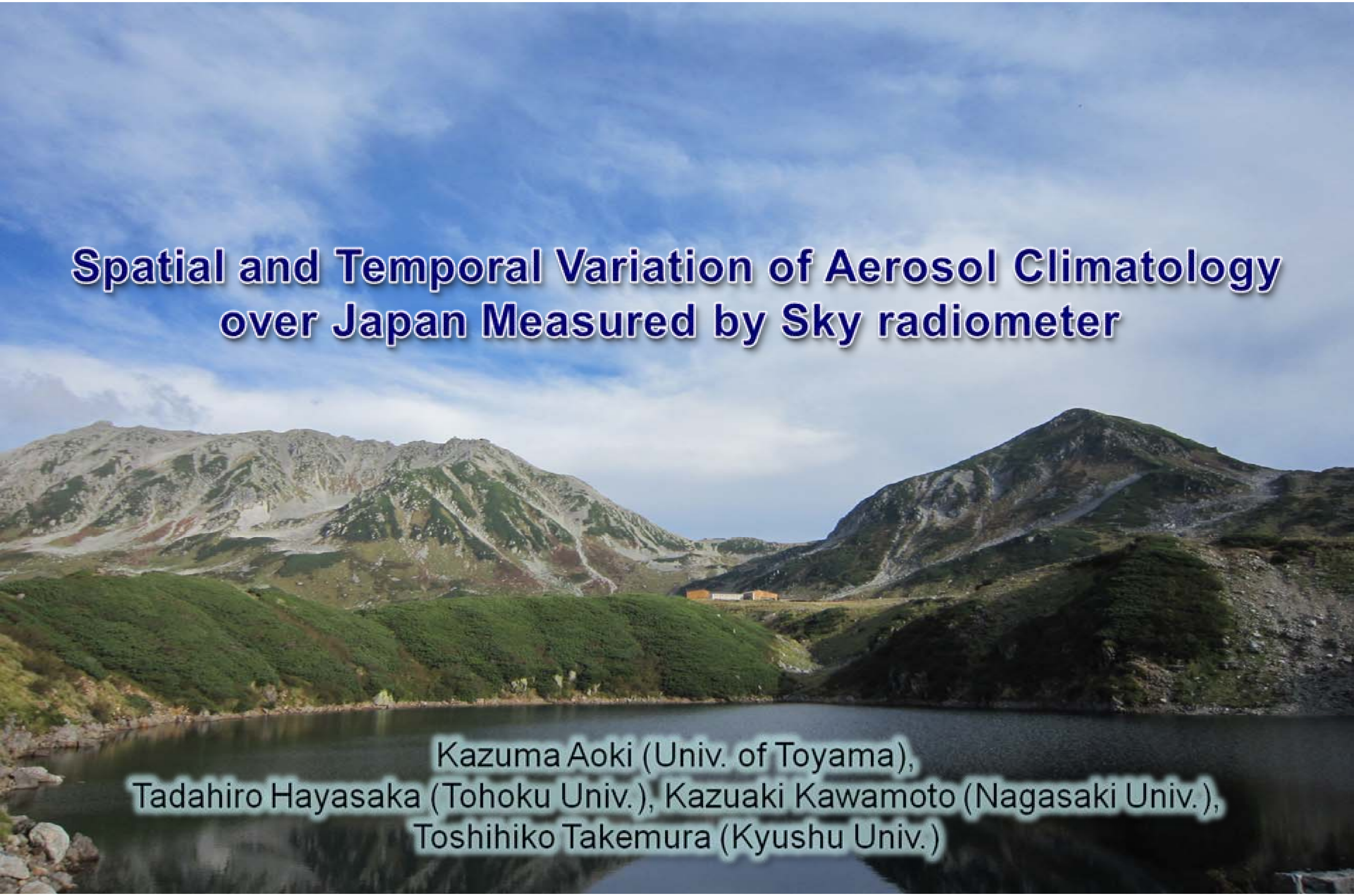
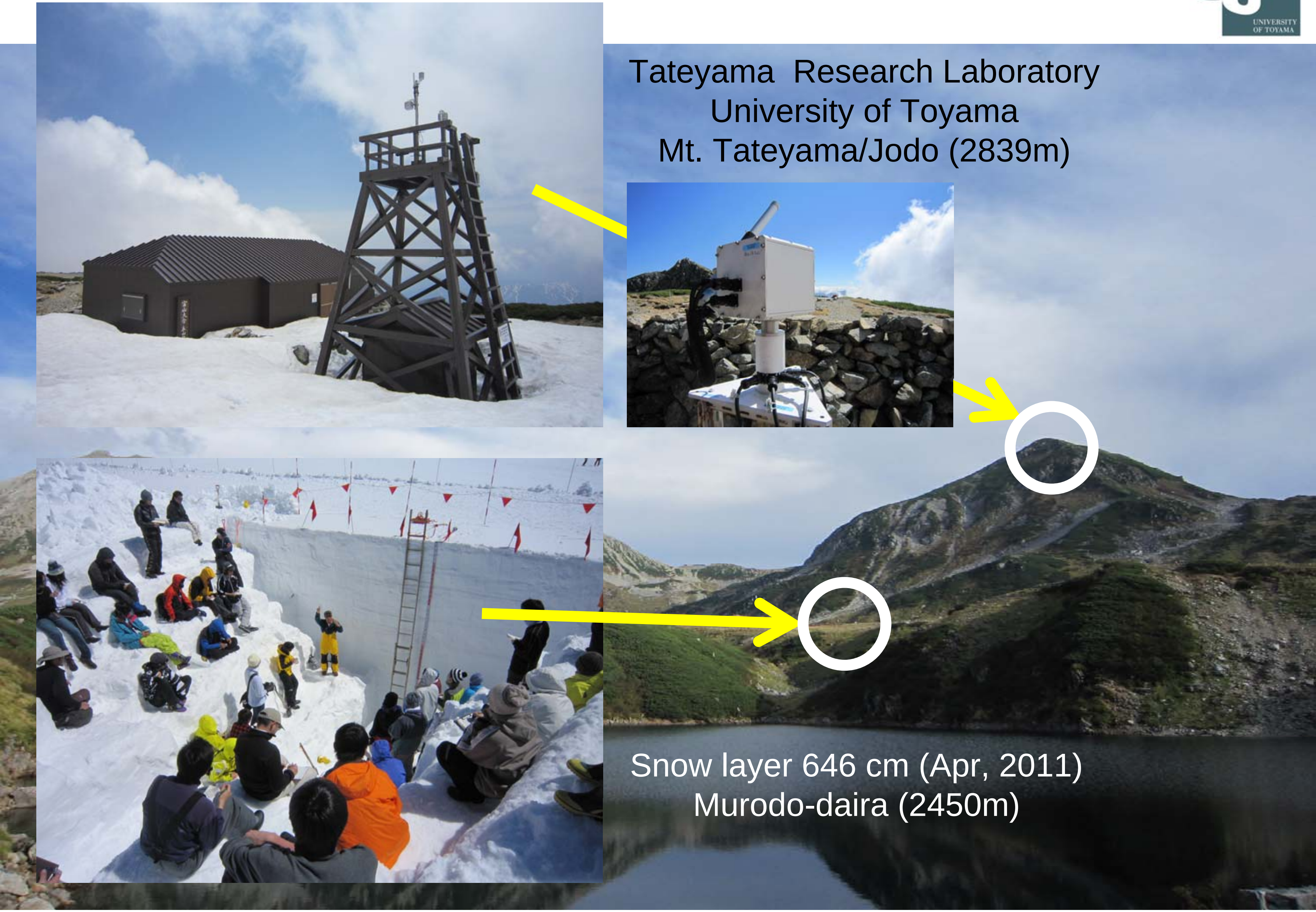


Spatial and Temporal Variation of Aerosol Climatology over Japan Measured by Sky radiometer

Kazuma Aoki (Univ. of Toyama),
Tadahiro Hayasaka (Tohoku Univ.), Kazuaki Kawamoto (Nagasaki Univ.),
Toshihiko Takemura (Kyushu Univ.)



Tateyama Research Laboratory
University of Toyama
Mt. Tateyama/Jodo (2839m)

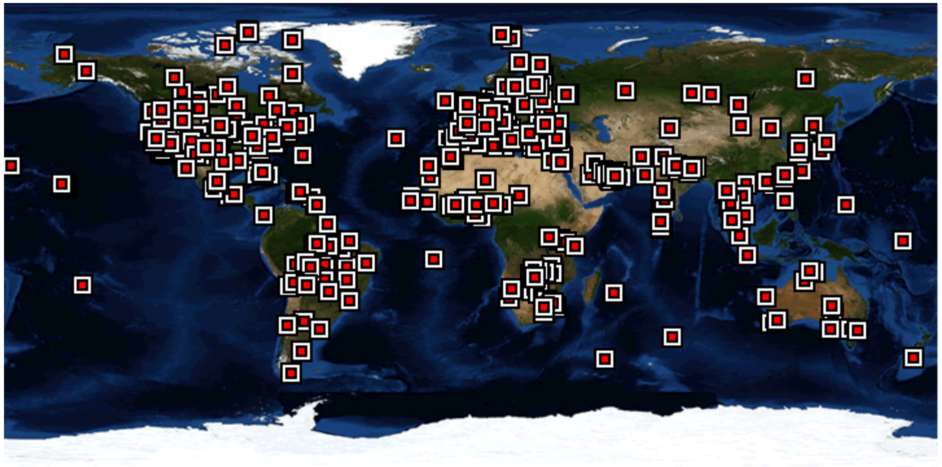
Snow layer 646 cm (Apr, 2011)
Murodo-daira (2450m)

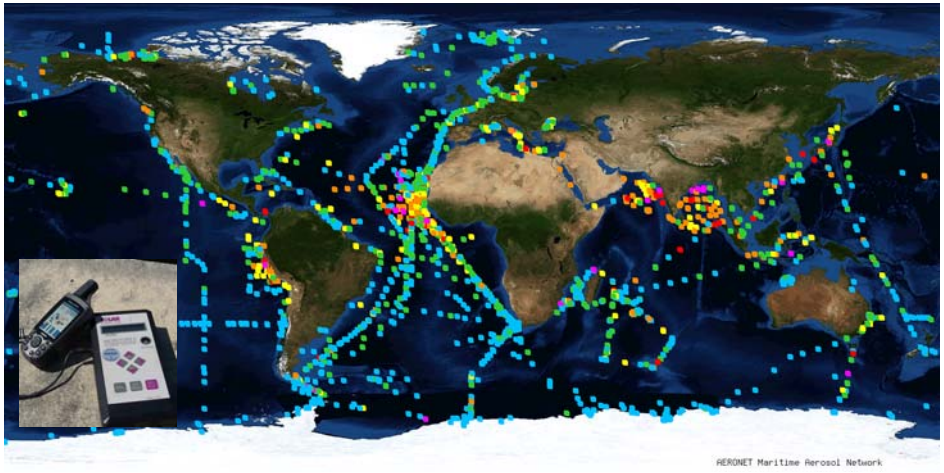
Table of Contents

- What is the SKYNET sky radiometers network and Sky radiometer observation method
- Spatial and temporal variation of aerosol climatology over Japan
  - SPRINTARS vs. Sky radiometer
  - Effect of cloud and other problem
- Summary

AERONET (NASA/GSFC)

AERONET
AEROSOL ROBOTIC NETWORK

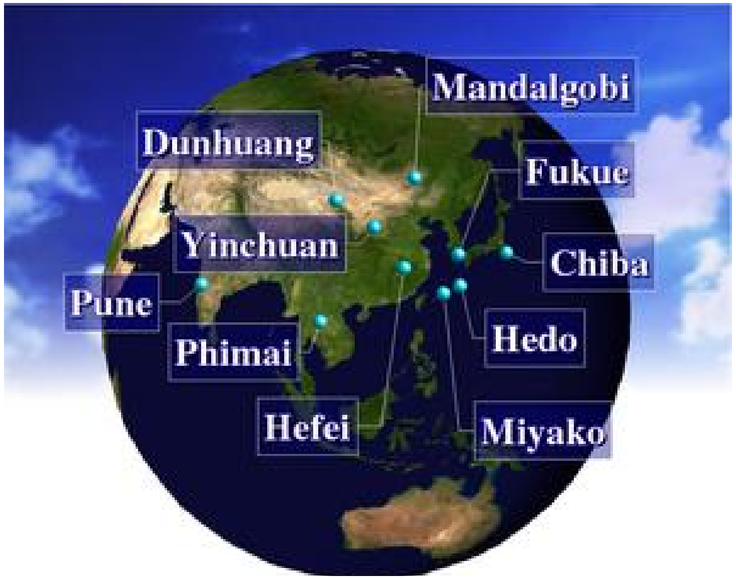



AERONET Maritime Aerosol Network

SKYNET (CEReS)

KSNET: Korean Skyradiometer network

ESR: European Skyrad user network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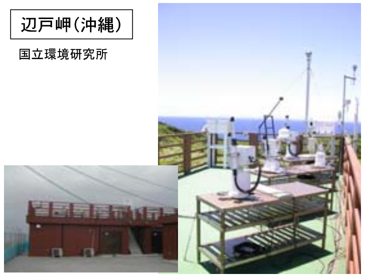
Dunhuang
Fukue
Yinchuan
Chiba
Pune
Phimai
Hedo
Hefei
Miyako



辺戸岬（沖縄）

国立環境研究所

ピマイ（タイ）

チュラロンコン大学

宮古島（沖縄）

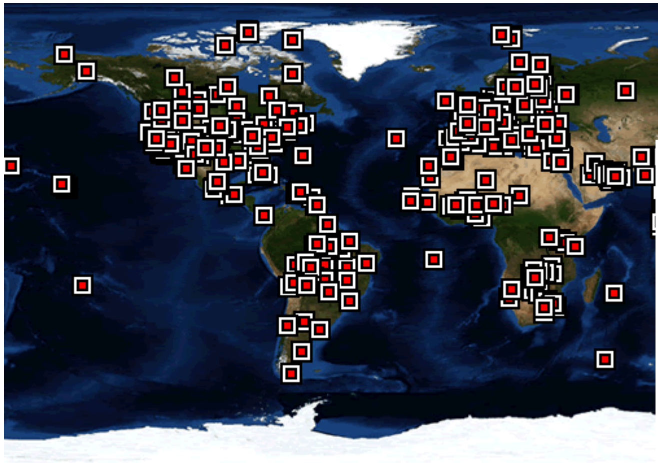
沖縄県溶接協会・日本ウェザリングテストセンター
気象研究所

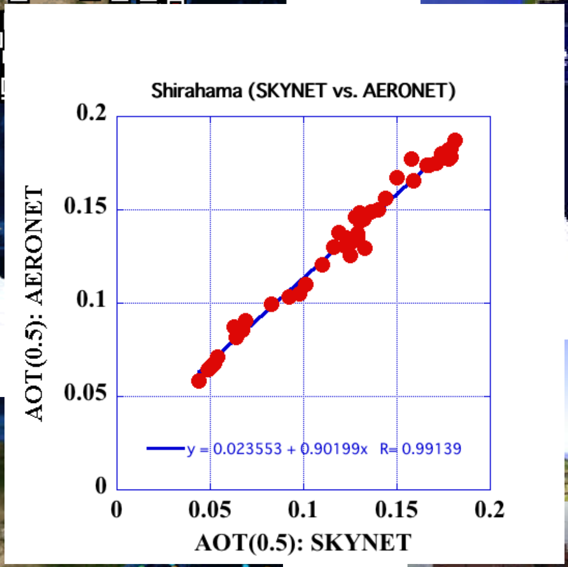
福江島（長崎）

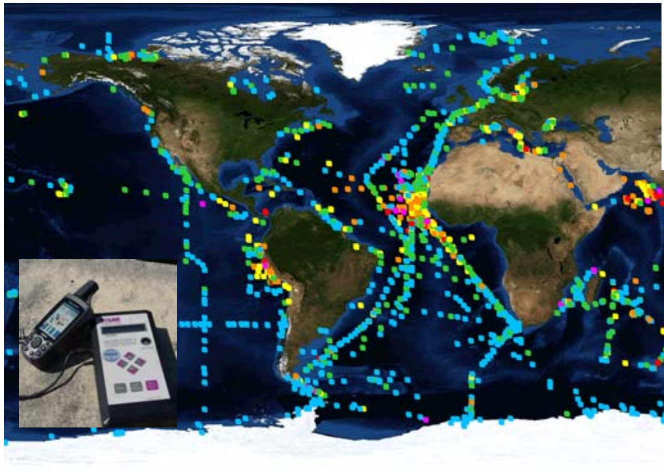
千葉大学

AERONET (NASA/GSFC)

AERONET
AEROSOL ROBOTIC NETWORK




Shirahama (SKYNET vs. AERONET)

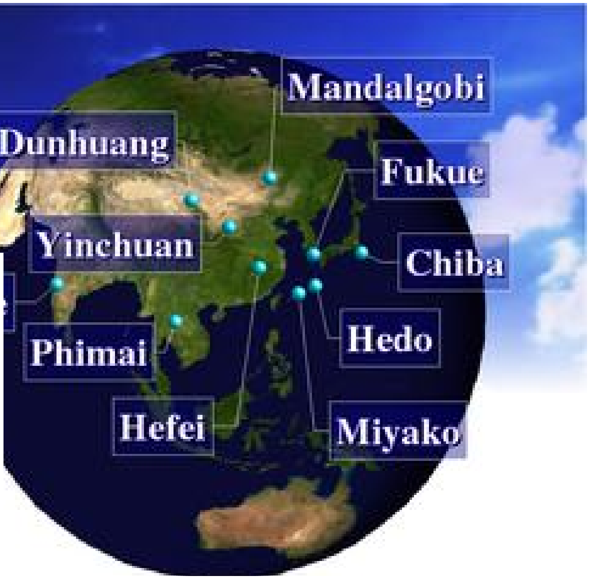

AERONET Maritime Aerosol Network

SKYNET (CEReS)

UNIVERSITY OF TOYAMA

KSNET: Korean Skyradiometer network

ESR: European Skyrad user network


Mandalgobi
Dunhuang
Fukue
Yinchuan
Chiba
Phimai
Hedo
Hefei
Miyako

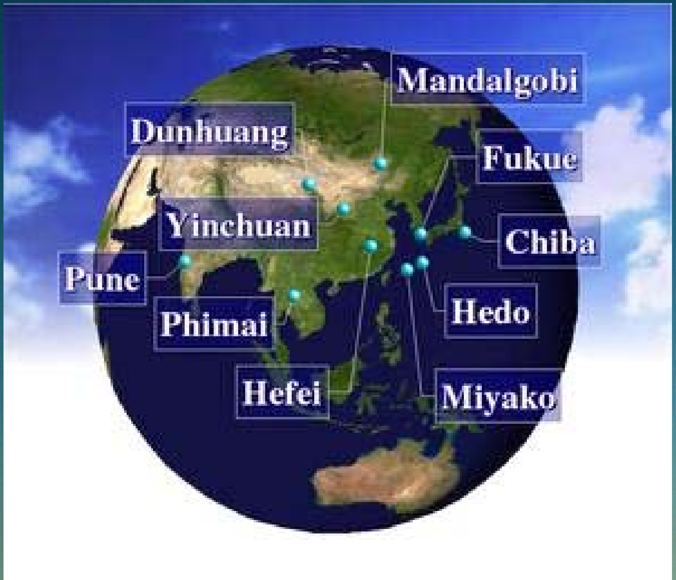
ピマイ(タイ)
チュラロンコン大学

宮古島(沖縄)
沖縄県溶接協会・日本ウェザリングテストセンター
気象研究所

福江島(長崎)
千葉大学

What is the SKYNET?

(*Prof. Takamura, CEReS, Chiba Univ.: http://atmos.cr.chiba-u.ac.jp/*)

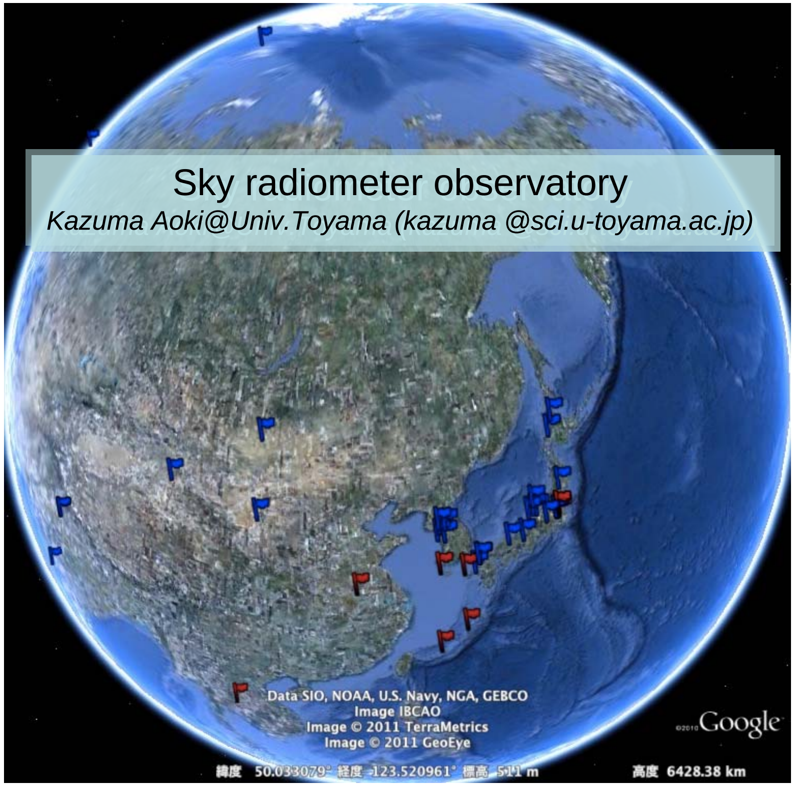

Mandalgobi
Dunhuang
Fukue
Yinchuan
Chiba
Pune
Hedo
Phimai
Hefei
Miyako

SKYNET super site
Cape Hedo, Okinawa, Japan (NIES)

1. SKYNET is a network to measure the atmospheric radiation budget and related atmospheric parameters, such as aerosol, cloud and so on.
2. SKYNET has an objective to estimate climatic impacts due to atmospheric parameters.
3. SKYNET is a useful validation network for satellite products (ADEOS-I, II, GOSAT, GCOM & etc) and numerical model (SPRINTARS & etc).
4. SKYNET project is a grass roots effort by many researchers who are interested in above items.

Sky radiometer observatory

Kazuma Aoki@Univ.Toyama (kazuma @sci.u-toyama.ac.jp)


Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image IBCAO
Image © 2011 TerraMetrics
Image © 2011 GeoEye
©2010 Google
緯度 50.033079° 経度 123.520961° 標高 511 m
高度 6428.38 km

About 50 site in the world

@ SKYNET/Sky (Univ. Toyama)

+ KSNET: Korean Skyradiometer network

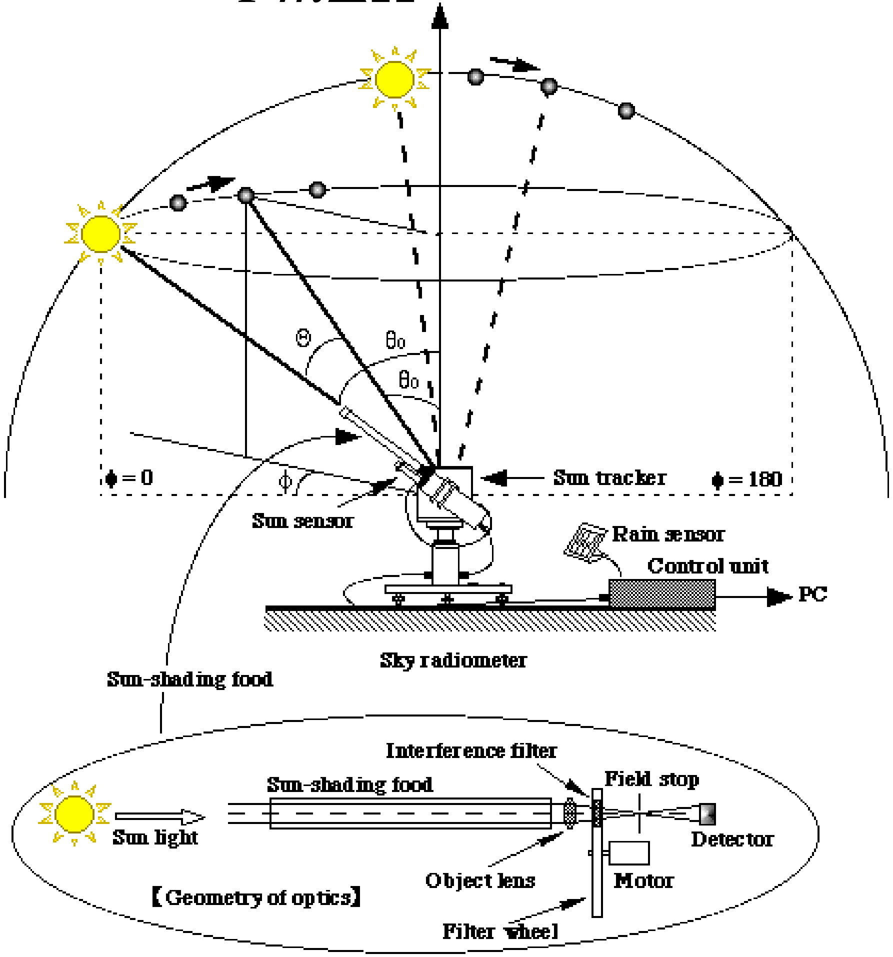
+ ESR: European Skyrad user network

@ SKYNET/Flux (SNU)
@ SKYNET/Lidar (NIES)
@ SKYNET/Microwave (CEReS)
@ SKYNET/Model (RIAM)
@ etc

We started the long-term monitoring of aerosols since 1994, by using a sky radiometer (Prede Co. Ltd.,) on SKYNET project. We are seeking in this data information on the aerosol and cloud optical characteristics with respect to their temporal and spatial variability and validation of Satellite and models

Detail of sky radiometer

$$R(\Theta) \equiv \frac{E(\Theta)}{Fm\Delta\Omega} = \omega\tau P(\Theta) + q(\Theta)$$


Θ
θ0
θ0
ϕ = 0
ϕ
Sun tracker
ϕ = 180
Sun sensor
Rain sensor
Control unit
PC
Sky radiometer
Sun-shading food
Interference filter
Sun-shading food
Field stop
Sun light
Detector
Object lens
Motor
【Geometry of optics】
Filter wheel

Aoki and Fujiyoshi, 2003, JMSJ

Ground-based

Ship-borne

- We observed only in daytime under clear skies at each site.
- Every 10 min/once (aureole)
- Every 1 min/once (direct)
- Data have been analyzed by an inversion software called SKYRAD.pack (Nakajima *et al.* 1996). Available version are SKYRAD.pack 4.2. L0, L1 and L2.
- POM-01: 315, 400, 500, 675, 870, 940, 1020 nm
- POM-02: 315, 340, 380, 400, 500, 675, 870, 940, 1020, 1627, 2200 nm

UNIVERSITY OF TOYAMA

Comparison between SPRINTARS and SKYRAD

SPRINTARS

(Spectral Radiation-Transport Model for Aerosol Species)

SPRINTARS is based on a atmospheric general circulation model developed by Center for Climate System Research, University of Tokyo, National Institute for Environmental Studies, and Frontier Research Center for Global Change (CCSR/NIES/FRCGC AGCM), and treats main tropospheric aerosols both from natural and anthropogenic sources (black carbon, organic matter, sulfate, soil dust, and sea salt). They are also categorized into PM10 and PM2.5. SPRINTARS calculates transport processes of aerosols (emission, advection, diffusion, wet deposition, dry deposition, and gravitational settling). The aerosol direct effect, which is scattering and absorption of solar and thermal radiation by aerosols, and the indirect effect, which is act of aerosols as cloud condensation nuclei and ice nuclei, are included in the calculation.

Present specifications
SPRINTARS version 3.84
horizontal resolution: T213 (0.5625 degrees longitude/latitude) or T106 (1.125 degrees longitude/latitude) or T42 (2.8125 degrees longitude/latitude)
vertical resolution: 56 or 20 layers (sigma coordinate)

SKYNET Sky radiometer network.

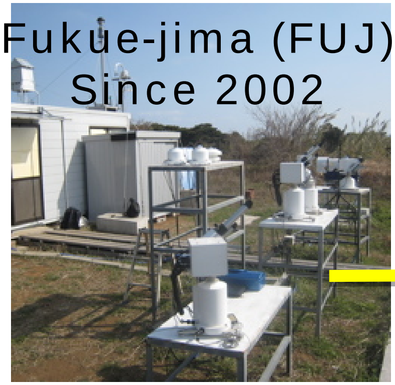
The Sky radiometer is a portable instrument that takes measurements only during daytime under clear sky condition. It observes both direct solar irradiance and diffuse sky radiation at every 10 minutes.

Present specifications
SKYRAD.pack version 4.2 L1 and L2 data

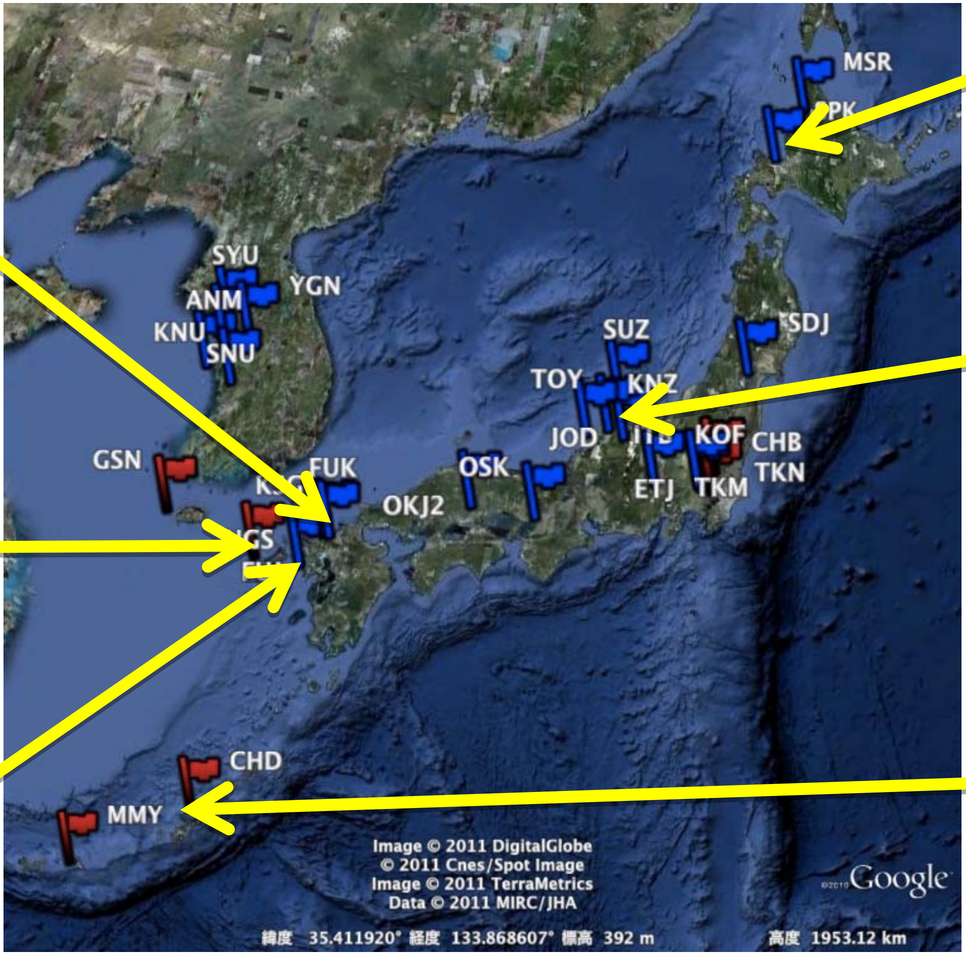
- ✓ Aerosol optical thickness at each wavelength
- ✓ Ångström exponent
- ✓ Single scattering albedo at each wevelength
- ✓ Size distribution of volume
- ✓ etc

SKYNET/Sky radiometer in East Asia

Kasuga (KSG)
Since 2003


Fukue-jima (FUJ)
Since 2002

Nagasaki (NGS)
Since 1996

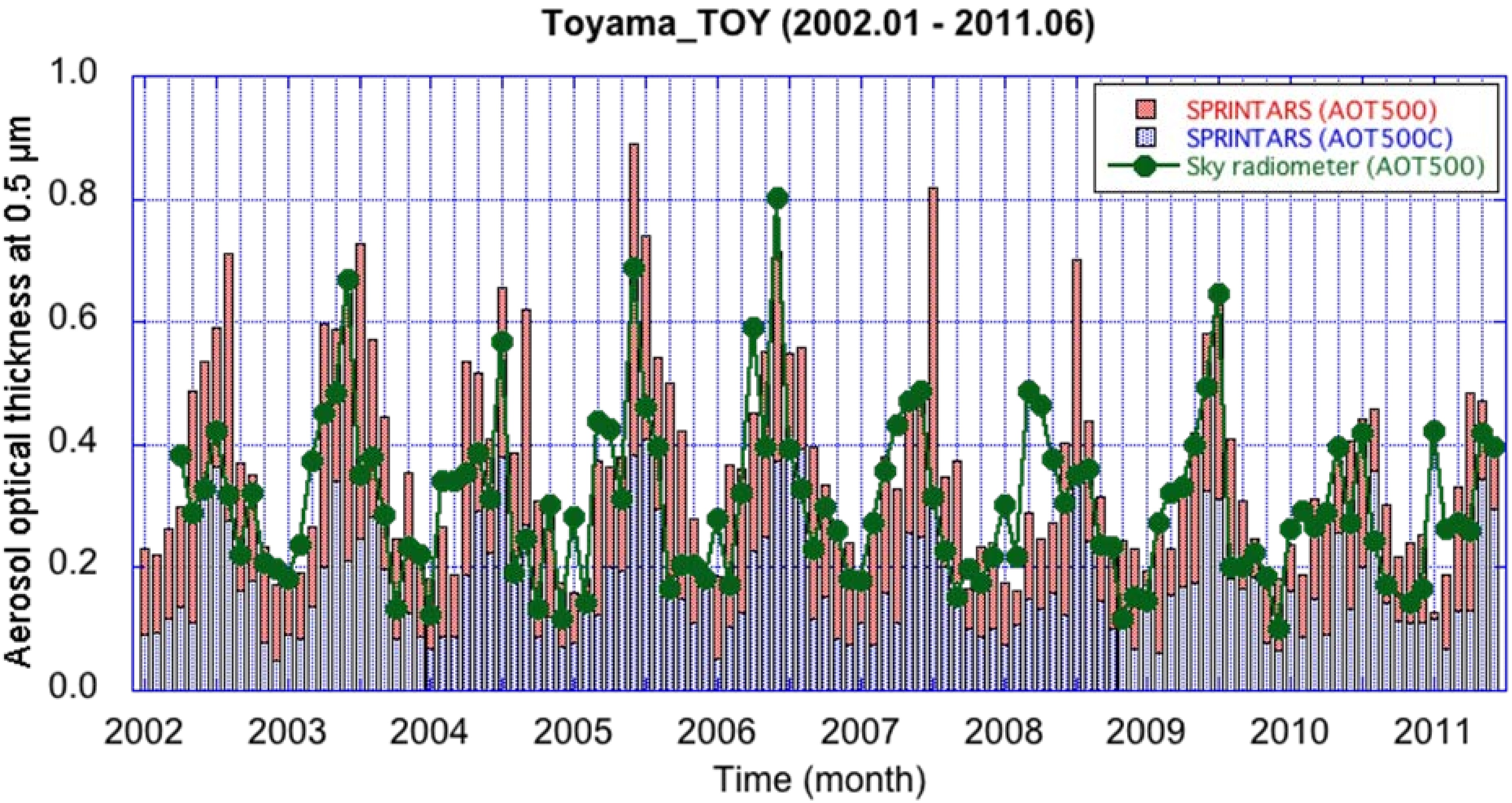

MSR
PK
SYU
YGN
ANM
KNU
SNU
SUZ
SDJ
TOY
KNZ
JOD
KOF
CHB
TKN
ETJ
TKM
GSN
FUK
OKJ2
OSK
GS
CHD
MMY
Image © 2011 DigitalGlobe
© 2011 Cnes/Spot Image
Image © 2011 TerraMetrics
Data © 2011 MIRC/JHA
Google
緯度 35.411920° 経度 133.868607° 標高 392 m
高度 1953.12 km

Sapporo (SPK)
since 1997

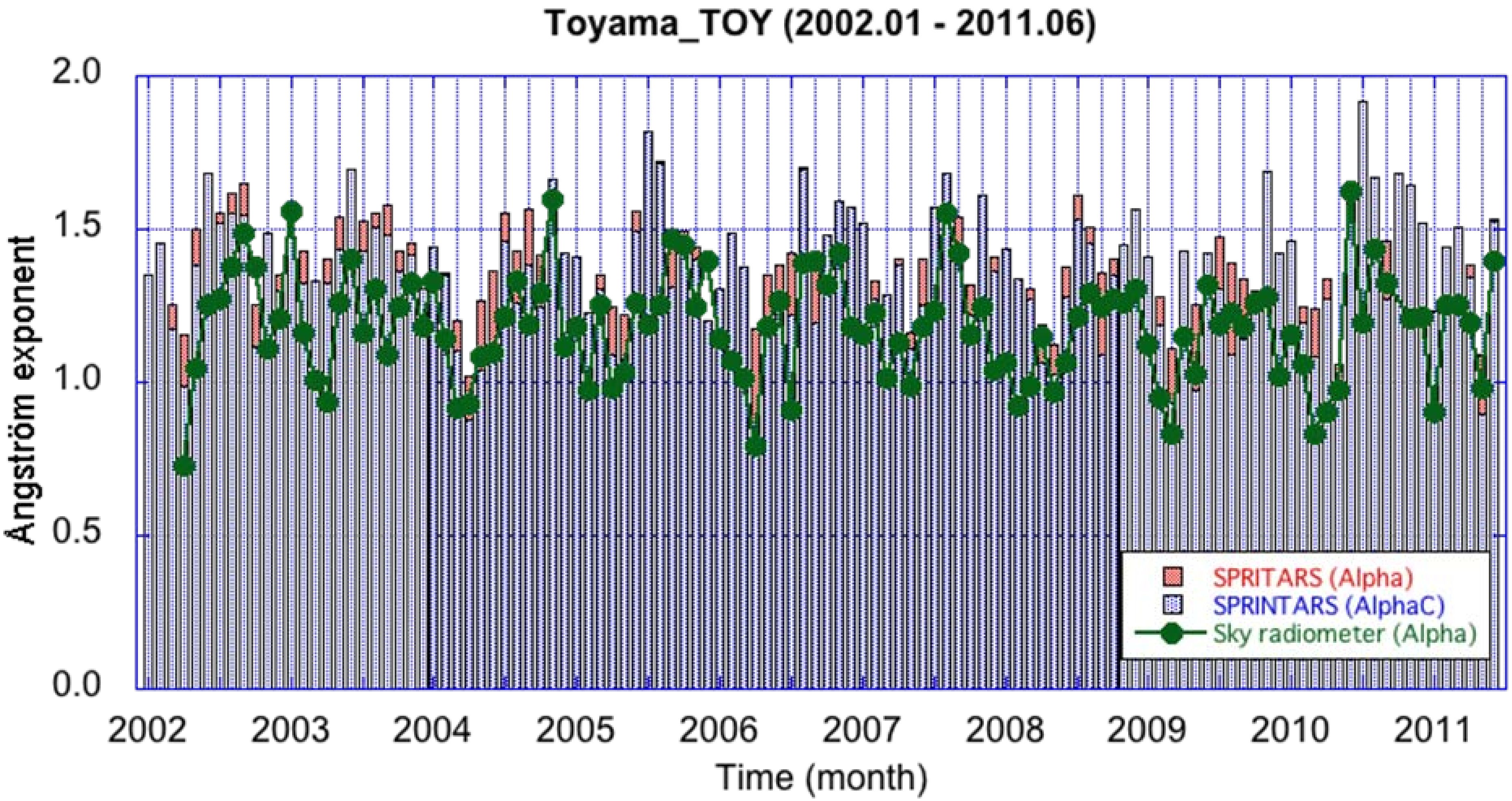
Toyama (TOY)
Since 2002

Cape Hedo (CHD)
Since 1996

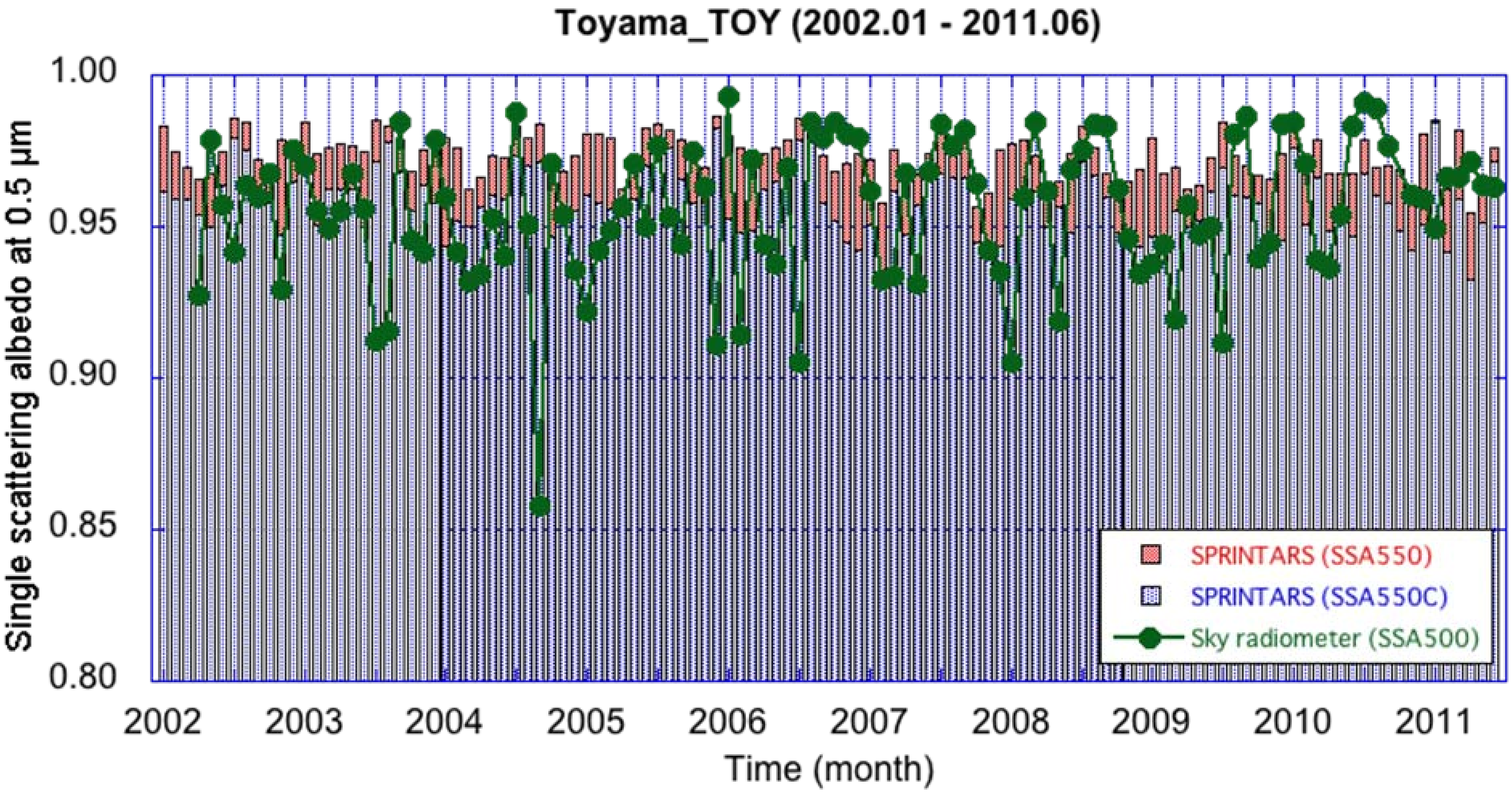
Comparison between SPRINTARS and SKYRAD



Comparison between SPRINTARS and SKYRAD

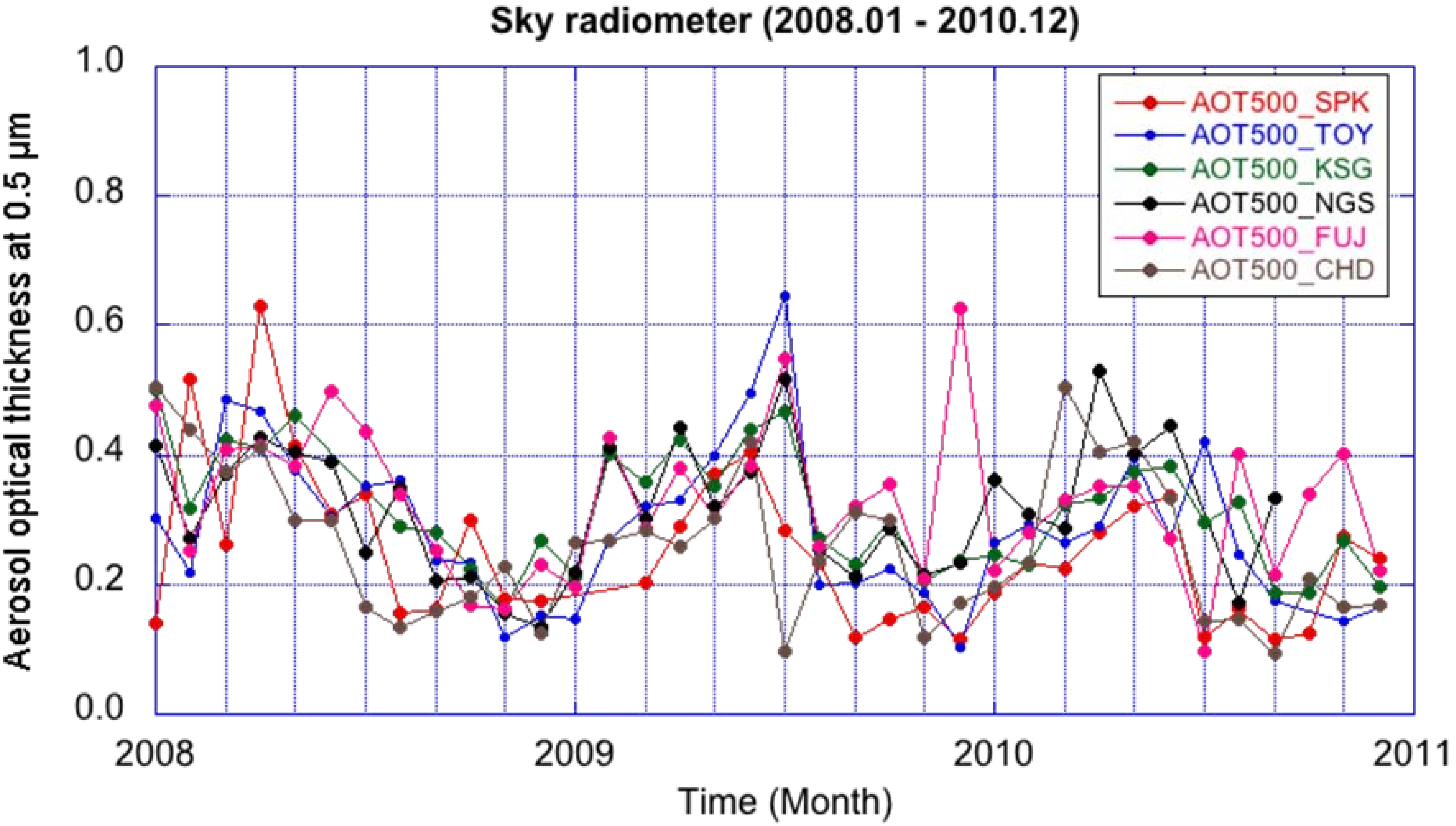


Comparison between SPRINTARS and SKYRAD



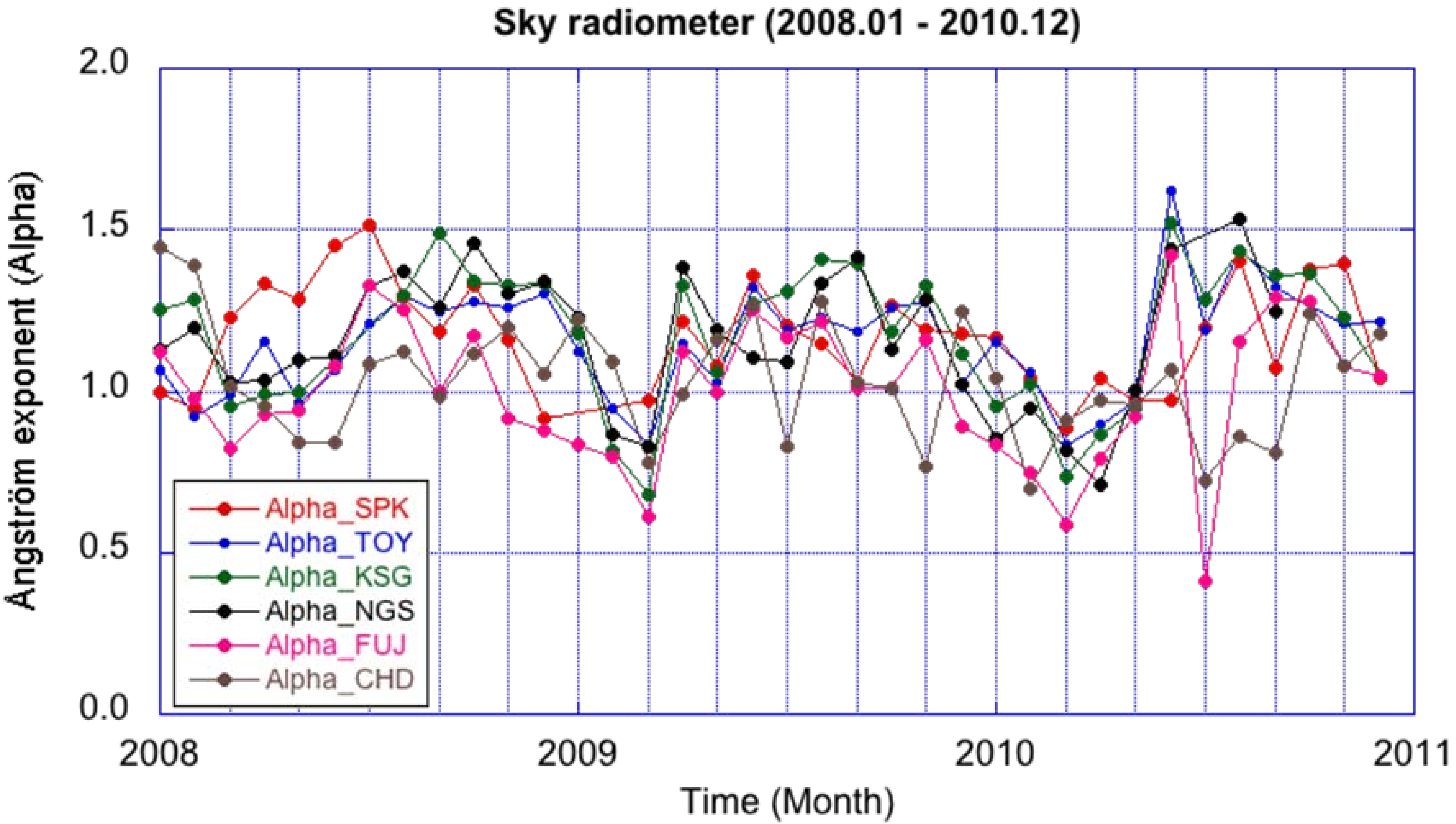
Aerosol optical thickness at 0.5 µm

2008.01 to 2010.12: Sapporo, Toyama, Kasuga/Fukuoka, Nagasaki, Fukue-jima, Cape Hedo



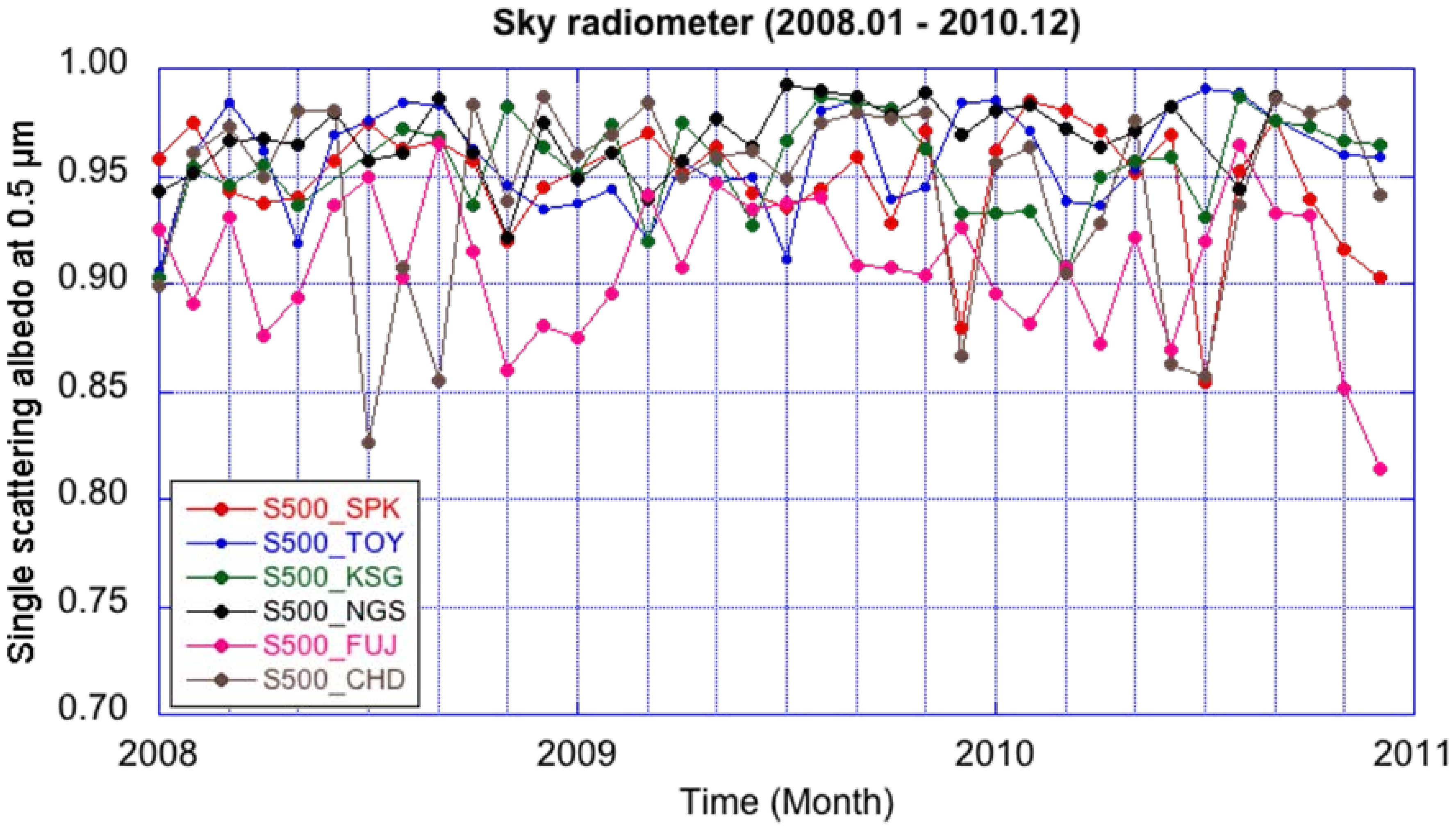
Ångström exponent

2008.01 to 2010.12: Sapporo, Toyama, Kasuga/Fukuoka, Nagasaki, Fukue-jima, Cape Hedo



Single scattering albedo at 0.5 µm

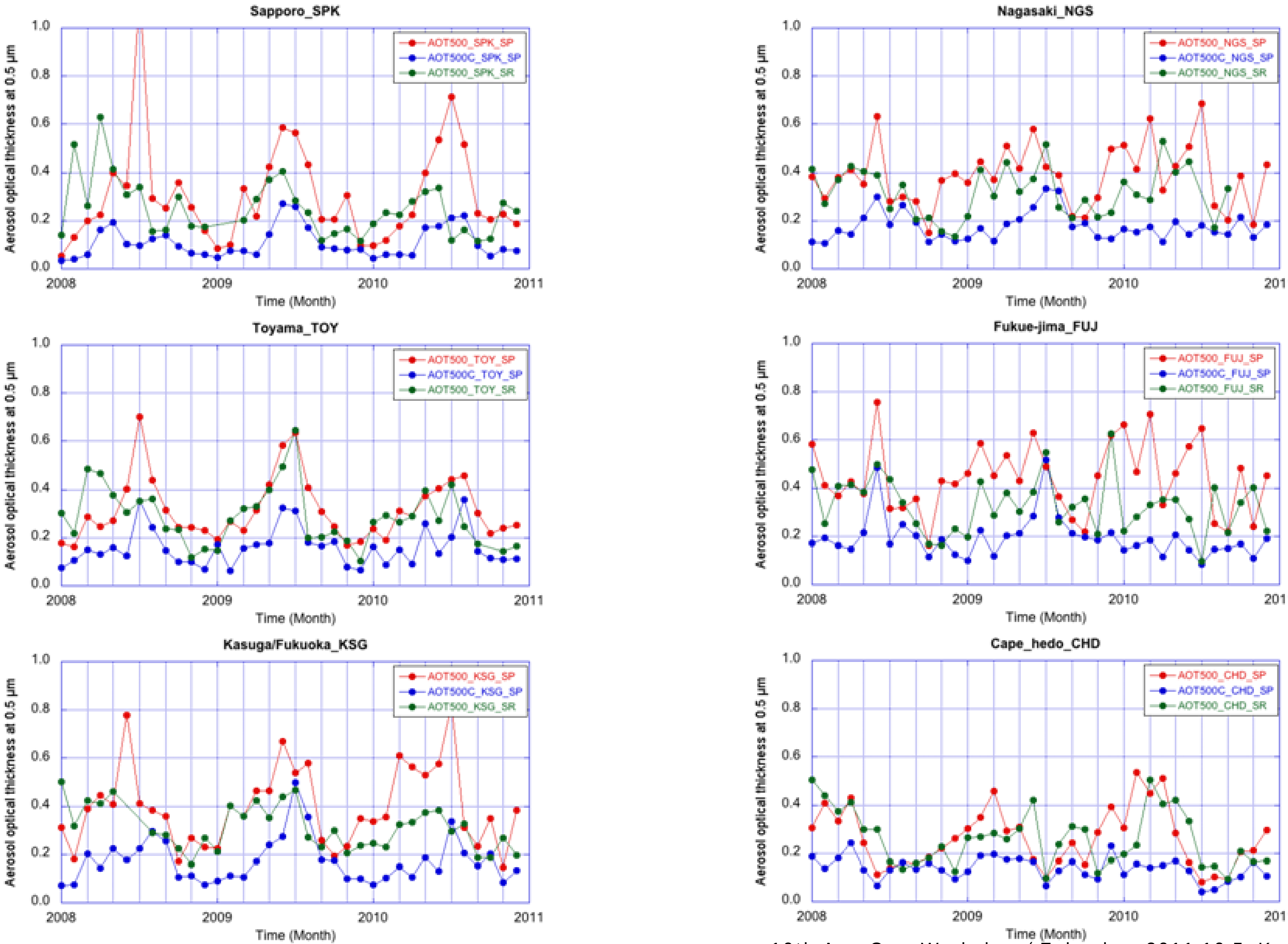
2008.01 to 2010.12: Sapporo, Toyama, Kasuga/Fukuoka, Nagasaki, Fukue-jima, Cape Hedo



10th AeroCom Workshop (Fukuoka : 2011.10.5, Kazuma Aoki)

Comparison between SPRINTARS and SKYRAD

2008.01 to 2010.12: Sapporo, Toyama, Kasuga/Fukuoka, Nagasaki, Fukue-jima, Cape Hedo



Comparison between SPRINTARS and SKYRAD

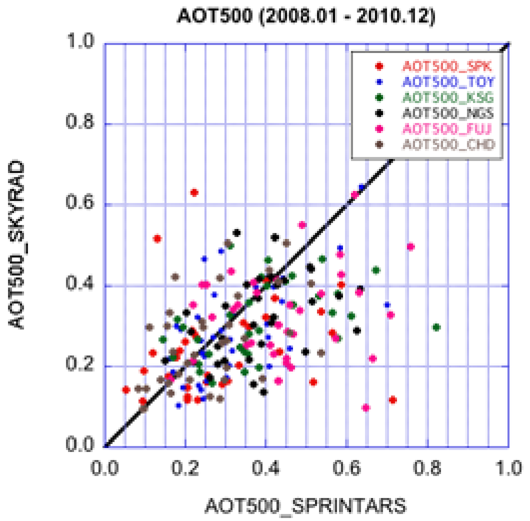
2008.01 to 2010.12: Sapporo, Toyama, Kasuga/Fukuoka, Nagasaki, Fukue-jima, Cape Hedo

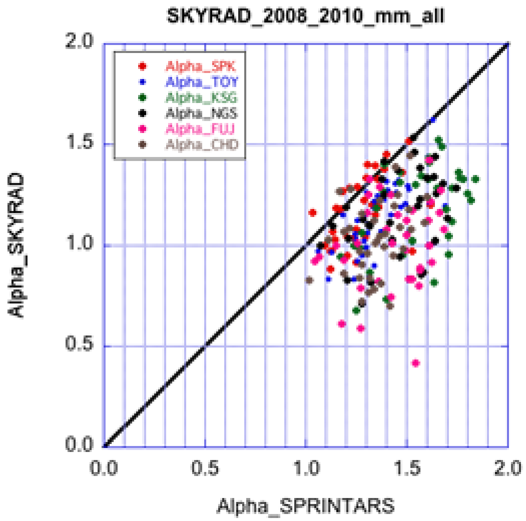
AOT500

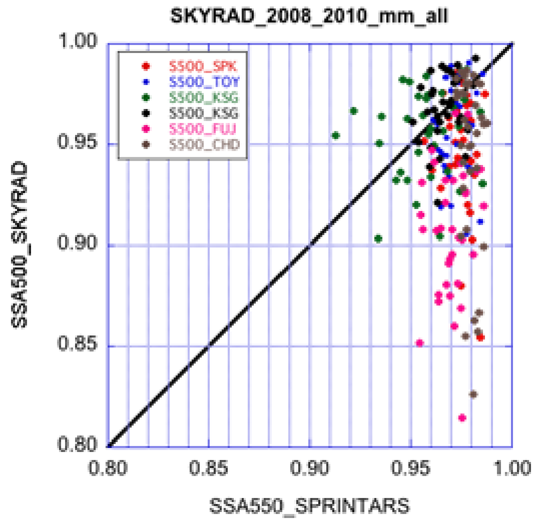
Alpha

SSA500

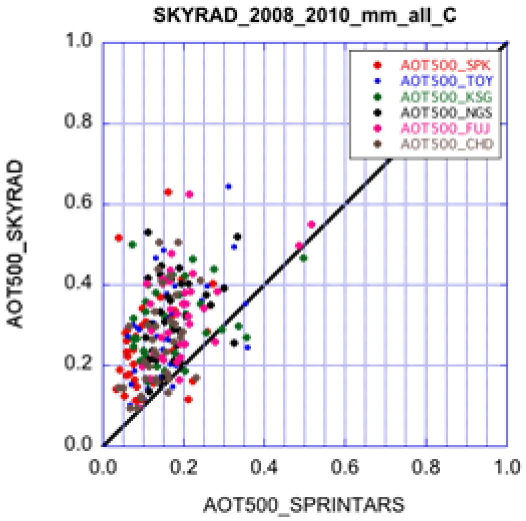
all-sky

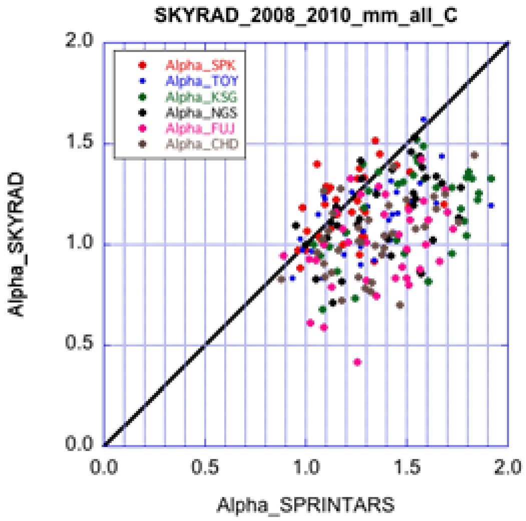


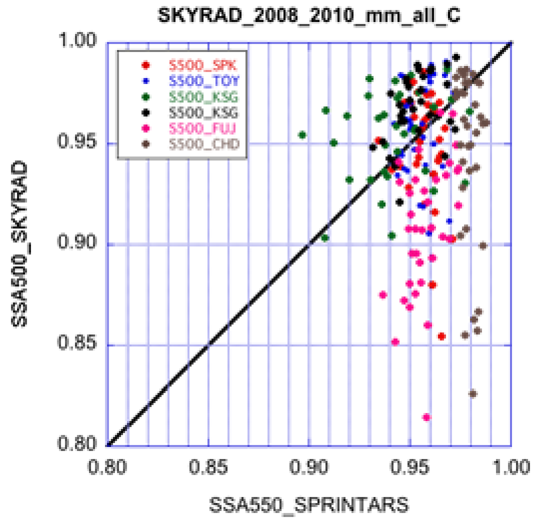




clear-sky





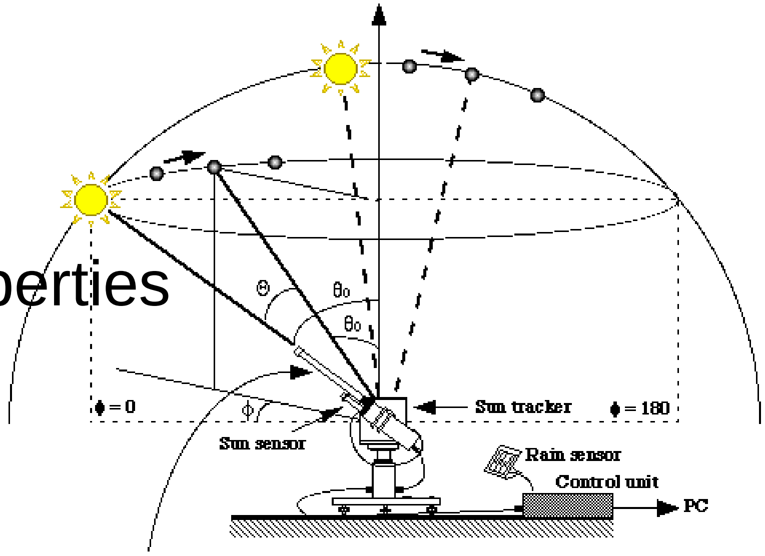


Discussion

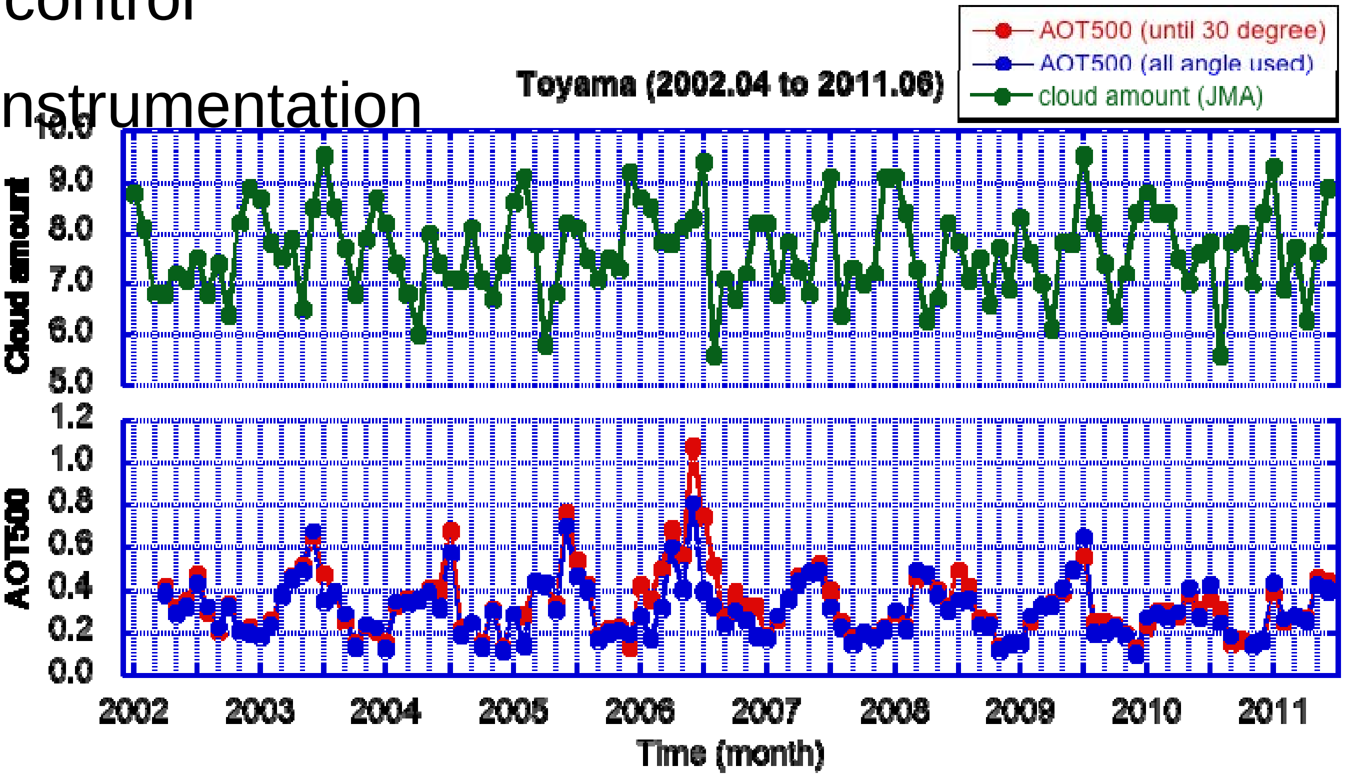
- ✓ What are we need data?
- ✓ Indirect effect and effect of aerosols between cloud? (include cloud screening)
- ✓ Comparison
  - ✓ LIDAR, MAX-DOAS and other instruments
  - ✓ Satellite, Model and other

✓ What are we need data?

What is true Aerosol optical properties measured by sky scanning radiometer?


Θ
θ0
θ0
ϕ = 0
ϕ
ϕ = 180
Sun tracker
Sun sensor
Rain sensor
Control unit
PC

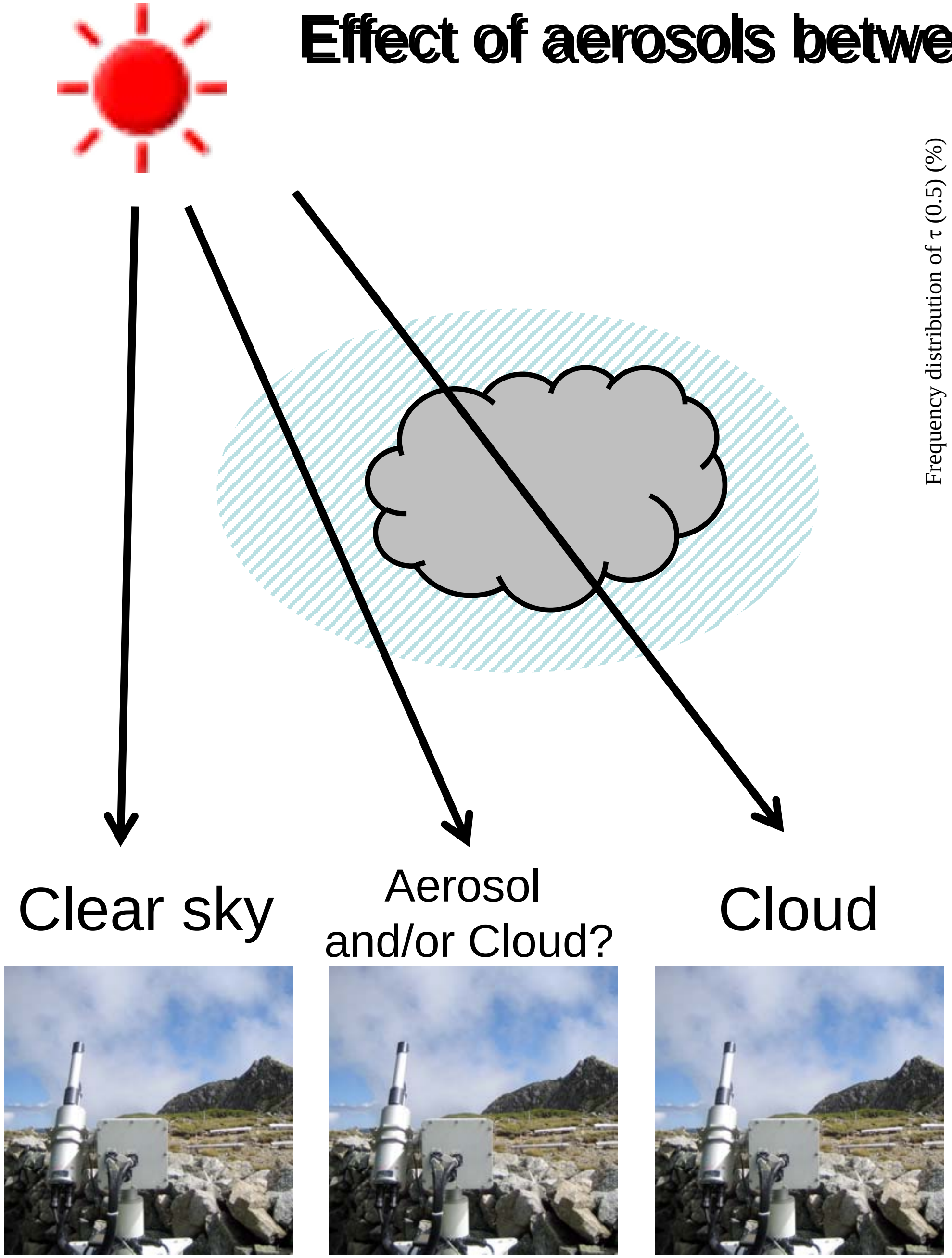
- + Quality control
- + Stable instrumentation



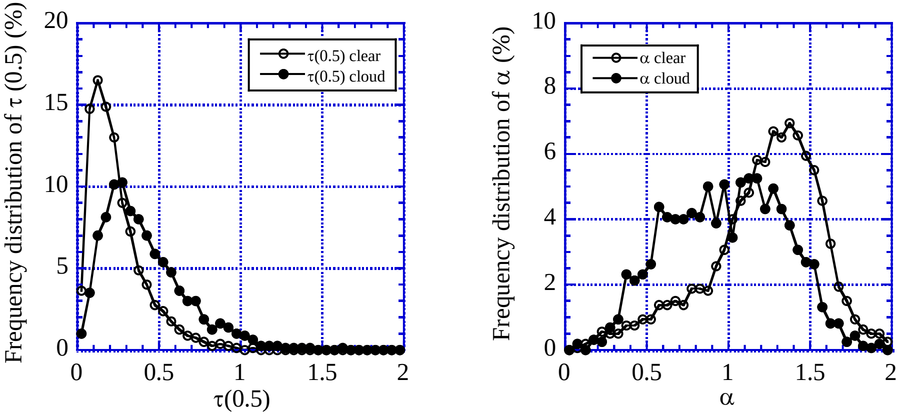
Discussion

- ✓ What are we need data?
- ✓ Indirect effect and effect of aerosols between cloud? (include cloud screening)
- ✓ Comparison
  - ✓ LIDAR, MAX-DOAS and other instruments
  - ✓ Satellite, Model and other

Effect of aerosols between clouds (Hybrid effect)



Aoki and Fujiyoshi, 2003, JMSJ



We eliminated 30 to 70% of the initial data because of cloud conditions and other factors. The sky radiometer, however, measures optical properties of aerosols under partly cloudy conditions if there are no clouds within 30 of the solar aureole radiation distribution.

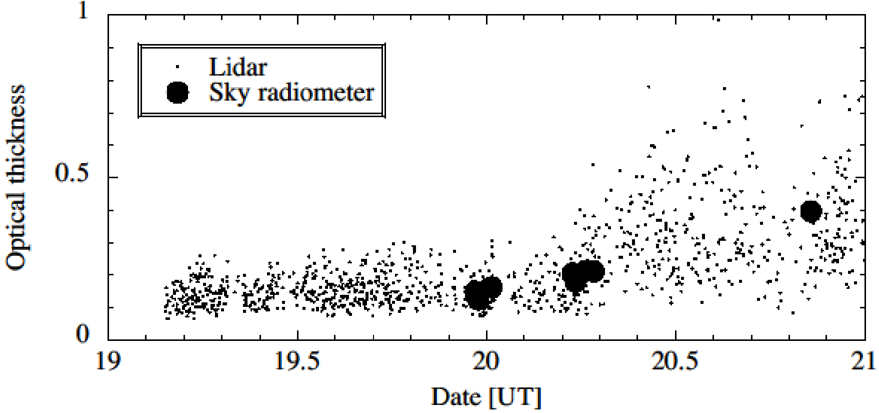
Since the relative humidity is high under cloudy conditions, the optical properties of aerosols that exist in between clouds would be changed. To study the properties, we compare the optical properties of aerosols measured under partly cloudy conditions with those measured under fully fine weather conditions. It was found that the seasonal mean of AOT(0.5) (or Alpha) measured under cloudy conditions was 1.5 to 1.8 (1.1 to 1.2) times as large (small) as that measured under clear skies.

Discussion

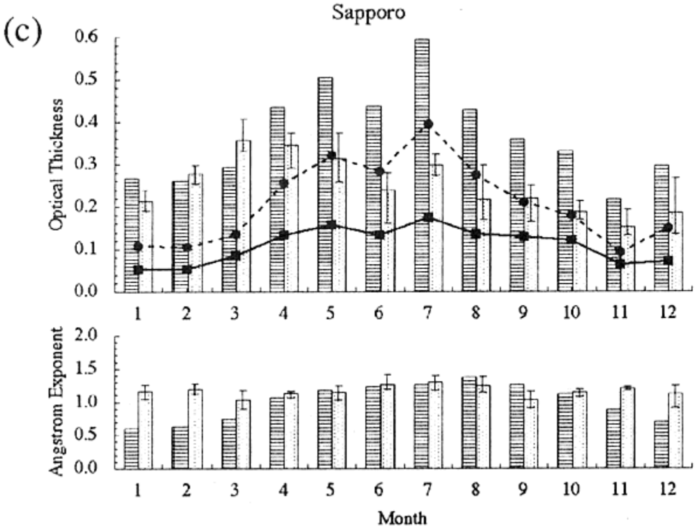
- ✓ What are we need data?
- ✓ Indirect effect and effect of aerosols between cloud? (include cloud screening)
- ✓ Comparison
  - ✓ LIDAR, MAX-DOAS and other instruments
  - ✓ Satellite, Model and other

Example of comparison results

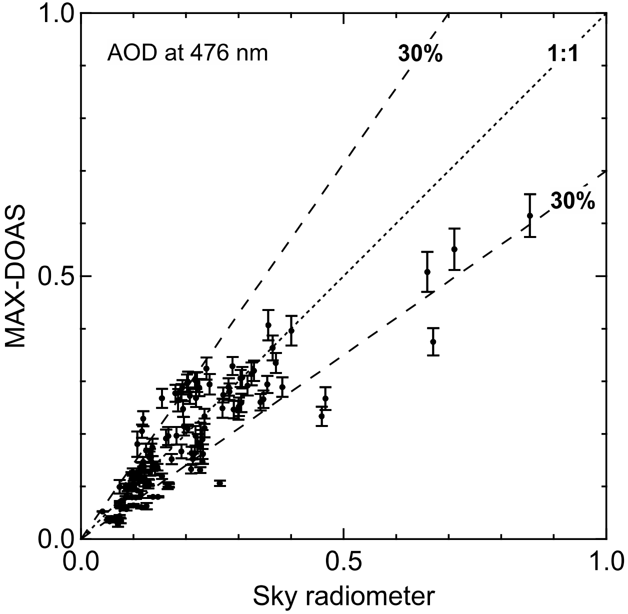
SKYRAD. vs. Lidar
MR01-K02 (Nishizawa et al. 2007, JGR)



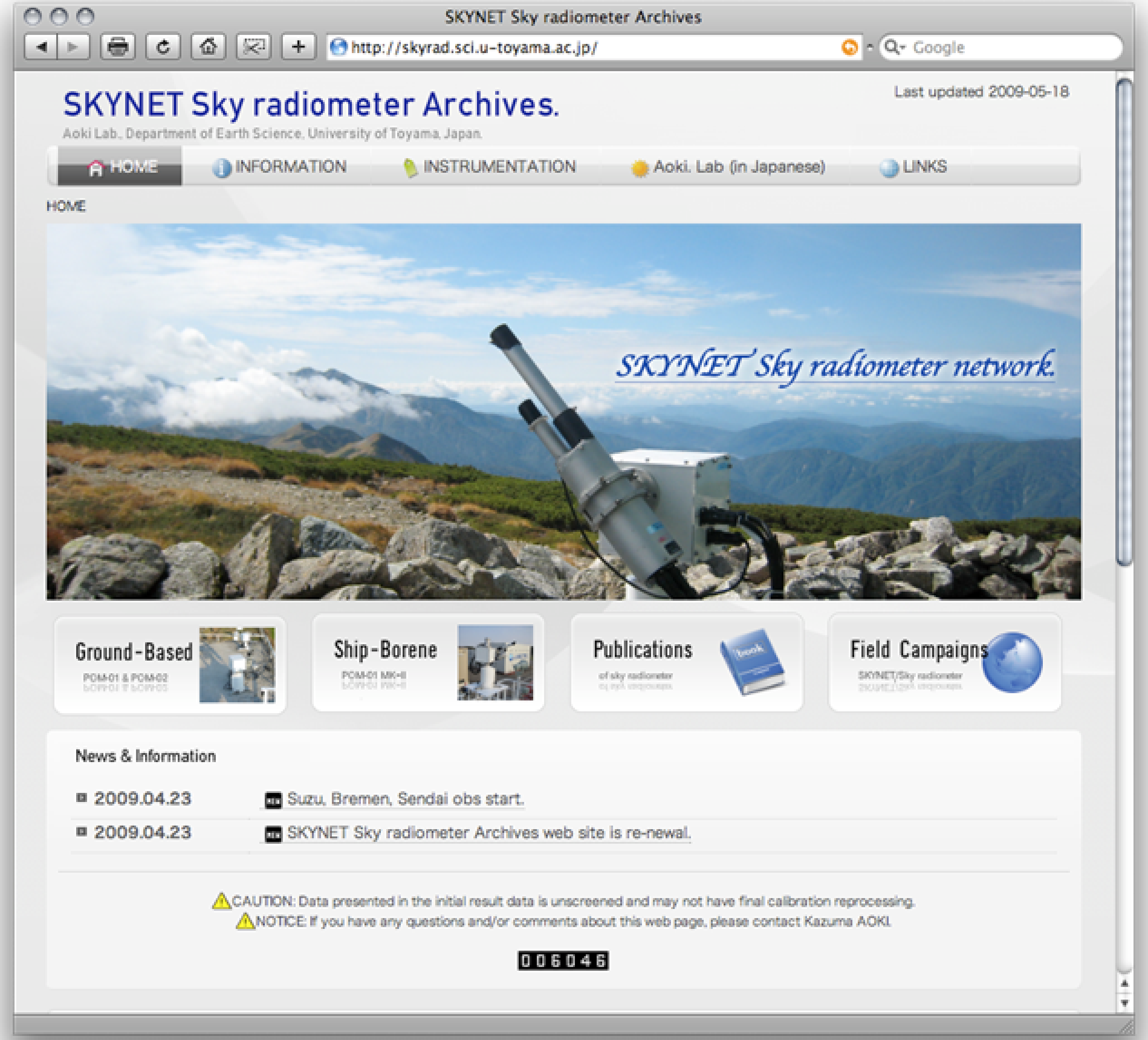
SKYRAD. vs. SPRINTARS
(Takemura et al. 2001, JMSJ)



SKYRAD. vs. MAX-DOAS
(Irie et al. 2008, ACP)



SKYENT/SKYRAD web:
http://skyrad.sci.u-toyama.ac.jp


SKYNET Sky radiometer Archives
http://skyrad.sci.u-toyama.ac.jp/
Google
HOME
INFORMATION
INSTRUMENTATION
Aoki. Lab (in Japanese)
LINKS
HOME
SKYNET Sky radiometer network.
Ground-Based
POM-01 & POM-02
Ship-Borene
POM-01 MK-II
Publications
of sky radiometer
book
Field Campaigns
SKYNET/Sky radiometer
006046

Last updated 2009-05-18

SKYNET Sky radiometer Archives.

Aoki Lab., Department of Earth Science, University of Toyama, Japan.

News & Information

- 2009.04.23 Suzu, Bremen, Sendai obs start.
- 2009.04.23 SKYNET Sky radiometer Archives web site is re-newal.

⚠CAUTION: Data presented in the initial result data is unscreened and may not have final calibration reprocessing.
⚠NOTICE: If you have any questions and/or comments about this web page, please contact Kazuma AOKI.

If you need result of our sky radiometer, please contact me.

kazuma@sci.u-toyama.ac.jp

Thank you.